MESOPOTAMIA IN THE EARLY HISTORY OF ALCHEMY

by A. Leo Oppenheim

The purpose of this article is to draw attention to two small and fragmentary cuneiform texts which, in my opinion, throw light on a chapter of the history of science which has hitherto been hardly touched upon.

One of these is a fragment of a Middle Babylonian tablet excavated in Babylon (Photograph Bab. K. 713), and the other a fragment of a tablet which was part of the library of Assurbanipal in Nineveh (K. 7942 + K. 8167). The former, or rather its photograph (the fragment itself is lost), is published here for the first time (Figs. 1 and 2) with the generous permission of Professor Dr. G. R. Meier, Generaldirektor des Vorderasiatischen Museums (Staatliche Museen, Berlin)[1]; the latter (Fig. 3) is in the British Museum, London, and was published by R. Campbell Thompson in his *Assyrian Chemistry* (London, 1925), Pl. 6[2]. Both fragments came under my scrutiny because of their similarity to tablets containing prescriptions for making colored glasses[3].

In this article I am including photographs of both fragments and, in addition, for the convenience of the reader, the very adequate copy (Fig. 4) made by R. Campbell Thompson[4].

Before presenting these documents in transcription and transliteration, I must caution the reader that they contain many new and technical terms which can hardly be understood since they belong to a text category of which little is as yet known. The translations are therefore affected by both reading and lexical difficulties and

1. I have to thank Dr. Franz Köcher for drawing my attention to this text.

2. The text was incorporated by H. Zimmern in his "Assyrische chemisch-technische Rezepte, insbesondere für Herstellung farbiger glasierter Ziegel, in Umschrift und Übersetzung", *ZA 36* (1925), p. 206.

3. The results of my study of the texts concerning glassmaking are being published under the title *Glass and Glassmaking in Ancient Mesopotamia.*

4. From R. Campbell Thompson, *The Chemistry of the Ancient Assyrians* (London, 1925), pl. 6.

are often tentative in more than one sense. Yet, the importance of the very existence of texts of this type seems reason enough to attempt even a provisional translation. The justification for my dealing with these fragments will become evident in the second part of this article.

Text No. 1 (Bab. K. 713)

Description :

Upper half of a narrow (2 1/2 inches) one-column tablet ; 18 lines preserved on the obverse, 8 lines, separated by an empty space, and a colophon of 2 lines on the reverse. The writing is arranged in two columns in a rather mechanical way, with words often split in the middle. This curious arrangement is found in poetic and other literary texts. The script is a typical Middle Babylonian hand which is difficult to date satisfactorily. Attention should be drawn to the elaborate and non-cursive form of the sign GÍN (lines 1, 3 and 4).

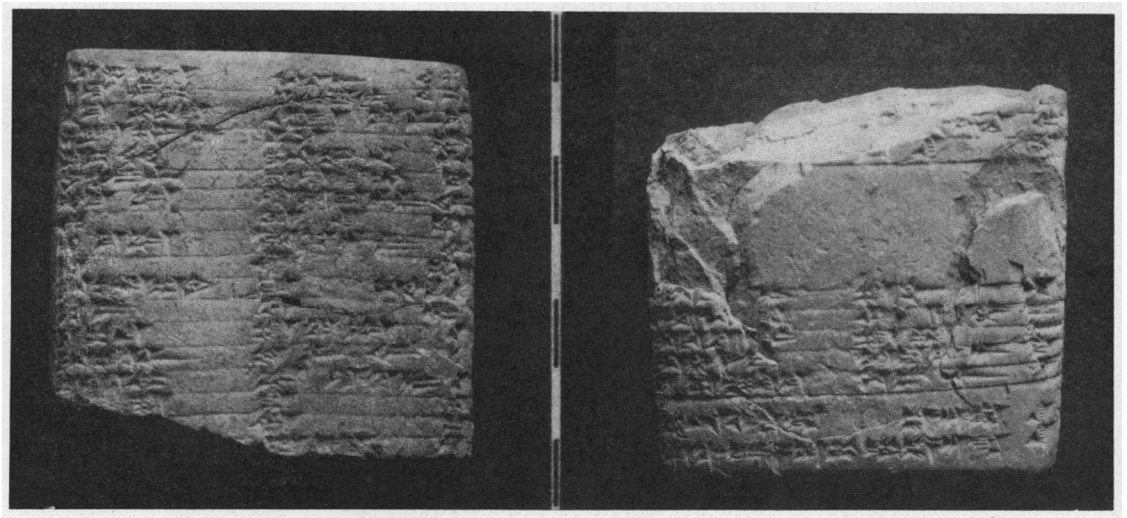


FIG. 1. — **Bab. K. 713**

Transliteration :

obv. *a-na* 5 GÍN NA_4.BABBAR.DIL.*ḫi-pi*
a la an ga ku ul lu mi *ḫi-pi*
1/3 MA LÀL.KUR.RA 10 GÍN TA 10 (SÌLA) GA
4 GÍN NAGA.SA_5 1/2 SÌLA GEŠTIN
5 TÉŠ.BI SÁR.SÁR *i-na pe-en-ti*
ni-bu-ú-ti ta-la-at-tak-ma
šum-ma IZI *la it-ta-an-pa-aḫ*
ul ta-ki-il
šum-ma IZI *it-ta-an-pa-aḫ*

10 *ta-ki-il*
i-na pu-ur ab-ni ša NA_4.SAL + KAB
ta-tab-ba-ak
ŠÀ-*bi-šu tu-ka-al-tam*
i-na li-ši te-pe-eḫ-ḫi
15 *ka-al* UD-*mi* IZI *la ka-tir(!)-tám*
[*ta*]-*šar-ra-ap*
[*tu-še*]-*lam-ma*
[...] *a ba ri*

break
rev.
break

[...*a-n*]*a* 5 UD-*mi*
[...*t*]*a-ki-il*

empty space of about six lines

i-na X-[*š*]*a(?)-tim tu-šal-bak*
IM.SAḪAR.NA_4.KUR.RA *ù a*-X-X
i-na ta-ba-a-tim tu-šab-šal
i-na uq-ni-i ta-ra-sa-an-ma
[(*ana* ?) I]ZI *ta-nam-di-ma* NA_4.DU_8.ŠI.A

Colophon : GABA.RI LIBIR.RA KÁ.DINGIR.RA^{ki}
É.GAL ^{d}AG.NÍG.DU.ŠEŠ LUGAL KÁ.DINGIR.RA^{ki}

Translation :

For (a quantity of) 5 shekels of (crushed) *pappardillu*-[1] stone (one line unintelligible) you mix one-third mina of mountain honey, 10 shekels of TA, one *sūtu* of milk, 4 shekels of red alkali (and) one-half sila of wine in one operation. You test (the mixture) on glowing[2] charcoal ; if the coals do not produce a flame it[3] is not reliable ; if the coals produce a flame it is reliable. (Then), you pour (the mixture) into a stone bowl of *algamišu*-stone ; you cover it ; you lute (it) with dough. You

1. The text has NA_4.BABBAR.DIL*ḫi-pí* which is to be read *pappardillu*, or, if the second DIL sign was lost in the break of the damaged original copied by the scribe of the present tablet, as NA_4.BABBAR.DIL.[DIL] which should be read, according to Miguel Civil, *papparminû*.

2. Literally "coals in the state of glow(ing)", cf. for the very rare *nibûtu* (Gilg. V III 19), SCHOTT in *ZA 42*, 120 and von SODEN, *ZA 53*, 225.

3. The syntax is difficult since the subject of *takil* is masculine and hence cannot be the fire or the coals.

heat it for a full day on a smokeless[1] fire. You take (the mixture) out and... (break) (break)... for five days, it is (not ?) reliable. You soak it in (liquid) [...]. You boil alum and... in vinegar. You steep (the stone) in lapis lazuli-colored liquid and place it in the fire and (then you have) a *dušû*-colored stone. Colophon : An old original from Babylon. Property of Nebuchadnezzar (I), king of Babylon.

The main problem concerning this text is the question of whether it contains one or two chemical recipes. The size of the tablet, the empty space on the reverse, and the parallel offered by the perhaps contemporary Middle Babylonian glass text BM 120960[2], favor the first possibility. The factors which suggest interpretation as two recipes are of a philological as well as technological nature. The fact that different precious stones are mentioned in the first and the last lines of the extant text (*pappardillu* and *dušû* respectively) demands an explanation since the first line can only refer to the manufacture of *pappardillu*-stone and the last line indicates clearly that the product obtained is, or rather looks like, a *dušû*-stone. There is furthermore a section on the obverse (lines 7-10) which describes a test (see below for details), and a parallel section must be assumed to have existed on the reverse as shown by line 2′ which corresponds to line 10 of the obverse. In addition, the existence of two prescriptions on the tablet is supported by technological considerations : the processes mentioned in the extant lines are of two distinct natures : one involving the application of fire, the other that of dyes in liquid solutions. I am, hence, ready to assume that the tablet originally contained two recipes : one for making an artificial *pappardillu*-stone and the other for making a stone looking like the *dušû*-stone[3].

On the basis of the above I will here proceed to interpret the two recipes as far as is possible in view of their poor state of preservation.

The first recipe demands at least three separate operations : first, combination of a number of ingredients (lines 1-5) ; second, testing of the mixture (lines 5-10) ; and third, firing of the mixture (lines 11-17). A fourth and final phase seems to be missing but it can safely be assumed that the second recipe began already in line 19 or 20.

1. The spelling *ka-tir-tam* is difficult : one expects *qatirtu*, parallel to the glass texts, see simply *ZA 36*, 182 : 16 and *passim*. Also below p. 35, note 5.

2. Published by C. J. Gadd and R. Campbell Thompson, "A Middle-Babylonian Chemical Text", in *Iraq 3* (1936), p. 87 ff.

3. There is still another possibility : the *pappardillu*-stone (of the first line) might have been used to form the core of the artificial gem which eventually was given the color of the *dušû*-stone. This would make sense only if, first, the stone used was of much less value than *dušû*, and second, if it contained silicates which, combined with the binder ("red alkali"), could form a glasslike mixture as the carrier of the final glaze. What little we know of the *pappardillu*-stone (see Landsberger in *AS 16*, p. 336) does not favor the possibility suggested here which cannot explain, moreover, the repetition of the testing operation *(latāku-takil)*.

Among the ingredients are a number of difficult words but the essential constituents are evidently crushed *pappardillu*-stone and red alkali[1], the latter to be used as a binder to fuse the apparently colorful mineral into an imitation bead. Honey served probably to knead the mineral and alkali powders into a specific shape. The function of the wine and milk to be added[2] remains obscure, the ingredient in line 4 (weight 10 shekels) cannot be interpreted, and I must point out again that I have failed to understand the damaged line 2[3] which either described the stone to be used or referred in some way to the entire process.

The testing (Akk. *laṭāku*) of the mixture was probably for ascertaining the correct relationship between binder (red alkali) and ingredients. A sample is to be thrown on the glowing (?) coals ; if it produces a flame it is considered *ṭakil* (lit. "reliable") and the actual firing can proceed. How the mixture is to be changed if the test is negative is not stated. The same test seems to have been applied in the second prescription of our fragment (only the last word — *[ṭ]akil* — is preserved) and this method might have been the reason for the scribe's placing of two apparently unrelated recipes on one tablet.

The firing of the imitation *pappardillu*-bead takes place in a crucible made of *algamišu*-stone. The reason for this specification is unknown but the presence of this stone which contains silicates[4], together with the alkali, would have improved the quality of the artificial "stone" as the craftsman might have known from experience.

As I have already pointed out, only the end of the second recipe is preserved. It must likewise have contained at least three operations : the assembling of the ingredients (lost in the break), the testing, and the final processing. The latter operation only is preserved in the five lines which appear on the reverse after an empty space and before the colophon. Of the test, only the last words in its two last lines are extant. What is left ("for 5 days" and *ṭakil*) suggests that the material to be tested was either fired or soaked for five days and, if it passed this test, was considered suitable. There is no indication as to what was tested but one may suggest that the stone which was to be dyed (see presently) was subjected to a treatment probably with a mordant to facilitate the application of the dye.

1. The "red alkali" occurs to my knowledge only here. In the glass texts, the source for alkali is ashes from certain plants.

2. The quantity of milk given here seems excessive. As to wine, the strange statement of Pliny (Book XIV, Chapter 8) comes to mind : "There is no wine that ranks higher than the Falernian ; it is the only one, too, among the wines that takes fire on the application of a flame".

3. The signs are quite clearly written but the gap at the end of the line prevents understanding. It is hardly *ku-ul-lu-mi*.

4. This is actually the case when one accepts the interpretation of the *algamišu* stone as steatite as was suggested in the *CAD* s. v. without the knowledge of the reference here discussed.

The five lines which describe the actual dyeing refer to a number of steps in an extremely compact fashion. My analysis of these lines is as follows : the first line prescribes the soaking (*šulbuku* from *labāku*, used normally in connection with brewing and irrigation) in a liquid, of an unspecified object. The next two lines refer to the preparation of a mordant made by boiling alum and another substance (the designation cannot be read) in vinegar. The last two lines refer again to the manipulated object and again do not mention it *expressis verbis*. They use the term *rasānu*, "to steep" (normally used in connection with tanning) and denote the liquid dye with the word *uqnû*, "lapis lazuli (colored)". After having been coated in such a bath with a liquid dye consisting probably of an emulsion of crushed blue glass suspended in the alum mixture produced according to the preceeding prescription (lines 2 and 3 of the final section), the object is fired to attain a blueish or greenish glaze.

The above interpretation is proposed on the basis of the assumption that this recipe deals with the coloring of a stone or crystal, although there is no direct reference to it. If the object had consisted of a body or carrier made of a faïence or another similar composition which was to be covered by a glaze, the repeated processing by means of liquid dyes would be senseless before the final firing. If, however, a pebble or a crystal was used, it could have been given the desired color before being coated with a thin translucent glaze. We would understand this process much better if we knew what is meant in this context by the designation *dušû* because we would then know whether the final glaze was meant to produce a shade or only a lustre. The *dušû*-stone is normally brownish or orange ; possibly some purple variety was the goal of the chemist in this instance.

As unsatisfactory and conjectural as the preceeding discussion of our text has been, the few established facts must be taken as proof that the tablet represents a new type of "chemical" text worthy of being considered on the same level as the contemporary tablet dealing with the manufacture of red-colored glass.

In two respects, the fragment is even more interesting. It is datable to the reign of Nebuchadnezzar I, i. e. 1124-1103 B. C., and thus belongs to the group of contemporary and even earlier glass texts (the above mentioned tablet BM 120960 and the "Hittite glass text" presented in my book) which attest a strong and varied technical tradition in the last third of the second millennium B. C. Our fragment is, in fact, a copy of an older text as is expressly stated in the subscript and borne out by the word "break" written above the line in small characters at the end of the first two lines of the text. Obviously a broken — and therefore probably unique and important — text was copied for preservation. The second subscript "Property (lit. 'palace')

of Nebuchadnezzar, king of Babylon" indicates that the tablet was copied for and had been part of a collection kept in the palace of that ruler. From this we learn that a royal collection existed in Babylon[1], and that beside the customary accumulation of scholarly and literary texts[2], it contained also tablets with technical instructions.

In this period of Mesopotamian history were first fixed in writing instructions for craftsmen such as the prescriptions for making certain perfumes[3], the already repeatedly mentioned glass text BM 120960, the instructions for the training of horses in Akkadian and in Hittite[4], not to mention the new glass text in Hittite. To the same period date, furthermore, the Middle Assyrian prototypes of the large collection of glass texts copied for the library of Assurbanipal (the series called "Door of the Kiln"), as certain linguistic peculiarities of these Neo-Assyrian texts suggest[5].

From the above evidence one can hardly fail to obtain the impression that some time in the second half of the second millennium B. C. the traditional, unwritten technology of Mesopotamia must have clashed on a rather broad front with a new technology of alien origin. The only archeological evidence we have for this encounter is the sudden appearance of technically very sophisticated glass containers all over the Ancient Near East — Egypt included. Since perfumes, of course, dyed stones, and certain metal alloys (see presently) do not leave much evidence, glass has become the only witness for these events.

Text No. 2 (K. 7942 + 8167)

Description :

Thin flake composed of two joint fragments, no reverse. Lower right corner of either a two or a three column tablet in the typical layout, script, and texture of the tablets of the library of Assurbanipal. The number of lines on the fragment (22) suggests columns of 60 or 80 lines each if one presupposes either a three or a two column tablet. Accordingly, the original tablet may have contained between 250 and 350 lines. The columns are separated by vertical double lines, and the sections by horizontal dividers of which two (one at the very end of the column) are preserved.

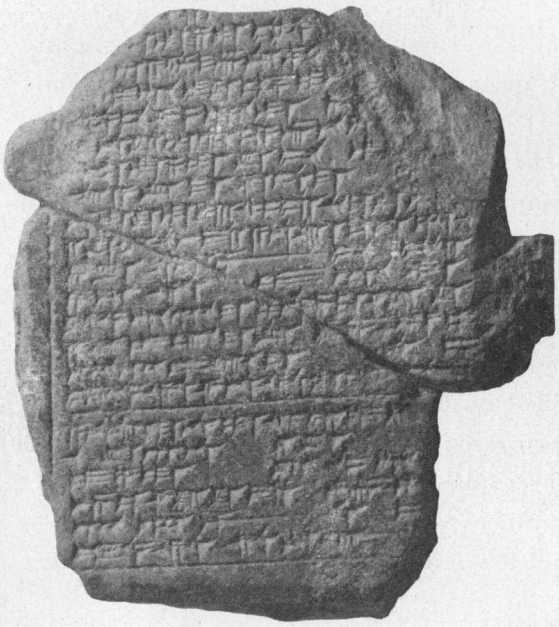
1. For such a collection kept at the court in Assur, see E. F. Weidner, "Die Bibliothek Tiglathpilesers I", *AfO 16* (1952), 197-215. This king who ruled from 1115 to 1077 B. C., was a contemporary of Nebuchadnezzar I.

2. See W. G. Lambert, "The Reign of Nebuchadnezzar I : A turning point in the history of Ancient Mesopotamian religion", in *The Seed of Wisdom* (Toronto, 1964), p. 3-13.

3. See E. Ebeling, "Parfümrezepte und kultische Texte aus Assur", Rome, 1950 (= *Or. NS 17*, 1948).

4. For the Hittite text see simply Anneliese Kammenhuber, *Hippologica Hethitica* (Wiesbaden, 1961) ; for the Akkadian, E. Ebeling, "Bruchstücke einer mittelassyrischen Vorschriftensammlung für die Akklimatisierung and Trainierung von Wagenpferden", *VIOF* 7 (1951).

5. A curious parallel between the 7th century glass texts and the fragment from Babylon here presented can be pointed out. In line 15 of the latter appears the phrase *išātu la qatirtu* "smokeless fire" which recurs repeatedly in the glass texts (see p. 32, note 1).



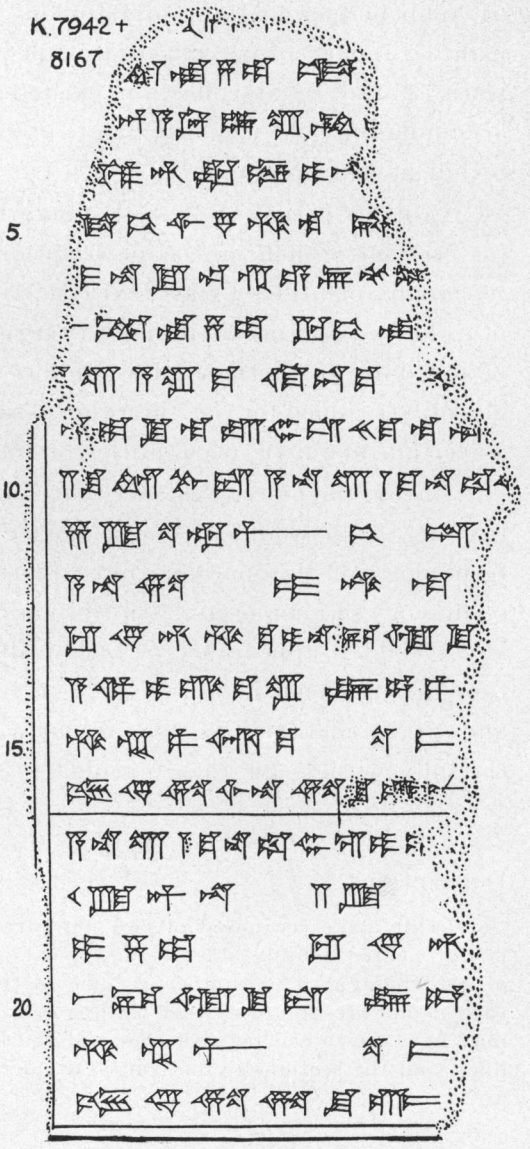


FIG. 2. — **K. 7942 + 8167**

Transliteration :

break

[x x *ina* I]ZI *ṭu-ṣa-ad* EGIR.[BI]
[KI.A].^{d}ÍD.LÚ.RU.GÚ x [ ]
[*pi*]-*ṣu-ṭi* ŠÌR-*as i-n*[*a*]
5 [E]GIR.BI IGI.4.GÁL.LA NA_4.[ ]
i-na lu-ba-ri-e sa-mu-ṭi [ ]
ina IZI *ṭu-ṣa-ad* TÉŠ.BI *ṭ*[*u-sa-am-ma-aḫ* or *-ba-al-lal*]

ana ŠÀ A ŠUB-*ma* E_{11}-*ma* x [ ]
[x]-*at-ku la ta-mi-iš mam-ma la tu-*[*kal-la-am*]
2 GÍN IM.GÍD.DA *a-na* ŠÀ 1 MA.NA URUDU.ḪI.[A ŠUB(?)][1]
6 GÍN UD.KA.BAR *bi-il-*[*lu-ka*]
a-na KÙ.BABBAR *i-bal-la-*[*al*]
ip-pat-ti-iq-ma i-na Ì.GIŠ *ù* ZÍD.[DA]
a-di i-ga-ma-ru in-nap-pa-a[*ḫ*]
ik-kap-par-ma ut-tab-[*bab*]
ziq-pat KÙ.BABBAR *ši-na* KÙ.BABBAR *šu-ú* NU [x x]
a-na ŠÀ 1 MA.NA URUDU *mi-si-i* 1/2 [MA.NA...]
1 GÍN AN.NA 2 GÍN [IM.GÍD.DA]
i-ṣa-ad ip-pat-ti-[*iq-ma*]
ina Ì.GIŠ *ù* ZÍD.DA *in-nap-*[*pa-aḫ*]
ik-kap-par ut-tab-[*ba-ab*]
ziq-pat KÙ.BABBAR KÙ.BABBAR *šu-ú* [NU...]

end of column

Translation :

(break) You melt [...] on the fire. Afterwards [you do...] (with) sulphur [...] you stretch white [curtains] in [...]. Afterwards [you...] one fourth of a shekel of [...] mineral. [You...] in red garments. You melt [...] on the fire. (Then) you mix in one process [both melted ingredients]. You throw (this) into water and you will take out (of it) [...]. ... Do not be careless (with respect to these instructions) ; do not [show] (the procedure) to anyone.

[You throw (?)] 2 shekels of IM.GÍD.DA mineral into one mina of unrefined (?) copper (also) 6 shekels of bronze. [Your] mixt[ure] will turn (lit. mix) into silver. Once it is cast (in molds) it will be made to flare up with a flame through (the use of) oil and flour (placed on it). When rubbed and polished these (objects) are *ziqpu* (or *ziqiptu*) of silver. This (kind of) silver [can]not [be detected].

Into one mina of refined copper (go) one-half [mina of ...], 1 shekel of tin, 2 shekels of [IM.GÍD.DA material]. It melts ; it will be cast [and] made to flare up

1. There is very little space for the sign RU which does not fit too well into the sentence structure. The two parallel passages line 9 to 10, and 16-17 are difficult to interpret. It seems that one should understand the first as either : "2 shekels of IM.GÍD.DA for each mina of mixed copper [also] 6 shekels of bronze" or "[Throw] 2 shekels of IM.GÍD.DA into one mina of mixed copper [also] 6 shekels of bronze" and the second as ,,for each mina of refined copper 1/2 [mina of..., also] 1 shekel of tin, 2 shekels of IM.GÍD.DA." Both alternatives for the first phrase are syntactically unsatisfactory.

in a flame through (the use of) oil and flour (placed on it). When rubbed and polished (these objects are) *ziqpu* (or *ziqiptu*) of silver. This (kind of) silver [cannot be detected].

We are again confronted by the problem of deciding into how many sections the text should be divided for a correct understanding. The last section (lines 16-21) is set off by dividing lines and since the preceding lines (9-15) parallel closely lines 16 to 21, I assume that the scribe has forgotten to draw a dividing line after line 8 in order to separate the first from the second section[1]. This emendation can be supported by several observations. First, the second and third sections deal with the same topic, use identical technical terms, and nearly the same materials. They contain, furthermore, a number of parallel passages. None of the terms and phrases recur in the first section which, in turn, is characterized by other style features and set apart by a different topic. The features of style are the repeated use of the phrase "afterwards" (EGIR.BI) which recurs occasionally in medical texts[2], and the use of the second person which does not occur in sections 2 and 3. The topical content of the first section is very difficult to ascertain because of its bad state of preservation; we shall discuss it after the parallel sections 2 and 3.

The purpose of the operations described in these two sections is clearly stated and is repeated with outspoken directness. The phrase *ana kaspi balālu* (in line 11) tells us that the mixture of copper, bronze and a mineral (reading unknown)[3] is to yield what the texts call "silver". This term is, however, qualified in the last line of each of the two sections. It says : "This (kind of) silver (is or can)not [...]" and the restoration I have proposed seems to be required by the context. The text obviously describes a method of producing a silver-like alloy from base metal ingredients — the "*leukosis* of copper" of alchemistic fame. The purpose of the operation is to deceive and the final formula is to allay any possible doubts of the "chemist". This interpretation is fully borne out by parallels from the texts from outside Mesopotamia which I shall adduce presently.

A difficulty which remains is that the product is in both instances called *ziqpu* or *ziqiptu* of silver. This may mean either that the word (appearing in both instances in the plural) denotes a finished product, perhaps objects cast in a mold *(paṭāqu)* and polished, that were sold as silver objects; or that the word denotes an ingotlike

1. Misplaced and missing division lines can also be observed in the glass texts from Nineveh.

2. Such are e. g. the texts *AMT 66*, 1 : 5 and 8; *AMT 23*, 10 : 2 and 3; *KAR 198* : 17 and 21. There, however, the formula is written EGIR-*šú*.

3. Literally taken IM.GÍD.DA means "long clay" which could describe a mineral showing nodules or elongated crystals.

form in which silver was customarily traded. Philologically, the designation permits no decision in this dilemma[1].

The sections 2 and 3 are largely parallel, the second being much less explicit than the first, a feature which can often be observed in collections of prescriptions when chemical recipes appear in pairs. The basic difference seems to be in the use of unrefined (lit. mixed) copper, tin, and bronze in the first recipe, and the use of refined copper, tin, and a small quantity (2 shekels) of an ingredient the name of which is lost in a break, in the second recipe. Both recipes, however, use the mineral (or ore) called IM.GÍD.DA. One has to assume that this ingredient contained the essential coloring — i. e. whitening agent which changed the copper-bronze mixture into an alloy resembling silver. It is difficult to think in this connection of a nickel ore because such a small amount cannot be expected to have the desired effect. Arsenic in some form seems a much more likely possibility. This, however, is a technical problem and not my main concern in the present article.

Technologically, each of the two recipes describes three steps : 1) the melting, mixing, and casting of the metals and the mineral ; 2) the treatment of the still hot castings with oil and flour ; and 3) the cleaning and polishing of the cooled-off castings. Of interest here is mainly the use of oil and flour, most likely to produce conditions of reduction and thus make the surface of the casting more pale. The polishing (*kuppuru* "to wipe clean" and *ubbubu* "to make shine") adds the finishing touches to the imitation silver.

We turn at this point to the first of the three sections contained in this chemical text from the library of Assurbanipal. Only 8 lines are preserved ; the designation of the finished product is missing in a break at the end of line 7, and the only ingredient mentioned in the extant text is sulphur. Moreover, the last line does not pertain directly to the prescription but addresses the chemist with a command to be careful and to keep the prescription a secret. There is still another irregularity in the text : the chemist is to spread (ŠÌR = *tarāṣu*, line 3) a curtain of a white material, and is to clothe himself in red garments (line 5). The remainder of the text tells us solely of the melting of two batches (*ṣuddu* in lines 1 and 6), and of their mixing (*summuḫu* or *bullulu* ; the verb is broken off, line 6). The molten subs-

1. The word *ziqiptu* (pl. *ziqpāti*) could be related to *zaqiptu* which denotes (see *CAD* Z s. v.) a standard for royal and cultic use, hence, in our case, a small replica of such an object ; and *ziqpu* (pl. also possibly *ziqpāti*) could denote a picket or lance-shaped ingot. Miss Reiner suggested to me the possibility of reading the sign ziq as zi(h) and hence the word as *zi'pāt(u)* and to connect it with *ze'pu* (*CAD* Z, p. 86 f.) in the meanings "mold for metal objects" (mng. 2) and "cast coin" (mng. 4). This would not only fit the context and the purpose of the recipe (see below n. 31) but also date it.

tance is then poured into water and taken out. The text breaks off at this point[1].

What makes this severely mutilated prescription so interesting and intriguing is the above-mentioned passage which addresses the chemist directly : "Do not be careless (with respect to these instructions)[2]. Do not [show] (the procedure) to anyone!" References to secrecy do not occur anywhere else in the cuneiform texts dealing with instructions written for specific crafts[3]. Perhaps the deviation in the present instance indicates that it represents a "shop tradition" — hence a specific trade secret — rather than a scribal collection of instructions of a technical nature. However, since the very nature and purpose of the operation described in this section is unknown, we cannot understand the circumstances which seem to have required secrecy.

The second unusual feature of the same section remains, for the same reason, likewise without explanation. The damaged lines (3 and 5) speak of the drawing of a white curtain for a specific (but unknown) operation and request the chemist to put on "red garments" for another operation. Again, there is an apparent but not real parallelism with the glass texts from Nineveh which begin with a ritual. The magic involved in that introduction, however, aims solely at the "consecration" of a furnace which is to be erected. The actual instructions for making glass show no ritual or magic acts whatsoever[4]. In medical texts where short rituals abound, they are consistently directed at the patient and the *materia medica* and not at the acting physician. Only in certain cult rituals which involve persons of high priestly standing do instructions occur concerning the ritual change of vestments which correspond to a certain extent to those in our text. This, of course, does not mean that either the nature or the purpose of such ritual acts was in any way parallel, but should only underline the fact that our section is quite extraordinary in this respect.

Before terminating the discussion of the fragment K. 7942 + 8176, I must stress that it represents only a small fraction of a large tablet which we may well assume was filled with a considerable number of diversified instructions for the

1. The first word on line 8 poses a problem because its first sign is badly damaged. If one could read it *la* (which is not likely), the world would be [*la*]-*at-ku* i. e. "tested, well proven" and thus refer to the process described.

2. The proposed translation expresses the meaning of the verb *mêšu* which always refers to negligence towards specific commands or instructions.

3. This statement is made expressly to contradict the assertion often found in popular as well as in Assyriological literature that there exists a glass text written purposely in such a way as to hide its secrets from outsiders. The playful but inconsistent use of certain rare and artificial sign values in the text BM 120960 (see also, p. 32, n. 2) which has given rise to this misconception could be read by any scribe of more than "primary" education — exactly as was done by the editors of the text who "deciphered" most of the writing. The text actually belongs to a category destined to be read by learned scribes. Note in this context the remarks made below p. 42, note 2.

4. For an isolated and atypical section which shows traces of a similar consecration ritual, see my book *Glass and Glassmaking in Mesopotamia.*

chemist. The loss of these instructions robs us of an important basis for comparison of Mesopotamian and alien technologies. The importance of the tablet is demonstrated by its inclusion in the collections of the library of the king of Assyria along with tablets dealing with the manufacture of colored glasses.

At this point, the patient reader is bound to ask why I have here presented these odd fragments of cuneiform tablets replete with incomprehensible technical terms and so damaged that the nature of the procedure remains rather obscure.

And here is my answer :

Two well known and early Greek manuscripts with chemical instructions, the Papyrus X of Leiden, and the very closely related Papyrus Graecus Holmiensis[1] dating from about the end of the third century A. D., contain a number of prescriptions which parallel to an astonishing degree both types of chemical instructions in cuneiform discussed above. These two papyri, both originating in Egypt — most likely in Thebes — seem to have survived the systematic destruction of all manuscripts dealing with alchemy, the making of gold and silver, allegedly ordered in 290 A. D. by the Emperor Diocletian. It is mainly on these two large papyri that the claim of Egypt, Hellenistic and pre-Hellenistic, as the mother country of chemistry and alchemy is based. In fact, the technological traditions which find expression in these Greek papyri from Egypt are attested already in Mesopotamia in the 13th and 7th centuries B. C. as shown by the fragments of clay tablets discussed in the first part of this article. This I will try to demonstrate by comparing the topical ranges of both sources and certain characteristic phrases which recur in them.

The respectively 101 and 150 recipes of the Leiden and Stockholm papyri deal with three main topics : methods of imitating precious metals, i. e. gold, silver, and electron, by making alloys whose color and polish is to resemble these metals ; methods of coloring (or otherwise changing) stones to give them the appearance of precious stones ; and, lastly, producing purple dyes of many shades. Many of the recipes of the Leyden papyrus and some of those of the Stockholm text deal with the first topic ;

1. For an English translation of the former (after the Latin edition of C. Leemans in 1885), see Earle R. CALEY, "The Leyden Papyrus", in the *Journal of Chemical Education*, vol. 3 (1926), pp. 1149-66 ; for the latter (after the German edition by Otto Lagercrantz, Upsala 1913), see the same author in the same journal vol. 4 (1927), pp. 979-1002. For the text type as such, see R. A. PACK, *The Greek and Latin Literary Texts from Graeco-Roman Egypt* (2nd edition, Ann Arbor 1965), p. 109, No. 1997 (Leyden papyrus), and 1998 (Stockholm papyrus), as well as Nos. 1999 ff. I owe this reference to Dr. David Pingree who has also drawn my attention to two more papyri of this nature listed in *Catalogue des manuscrits alchimiques grecs*, III (1924), p. 27. Some of these go back to about 100 A. D. There is much literature on these papyri. I found most instructive and original E. O. von LIPPMANN, *Entstehung und Ausbreitung der Alchemie* (Berlin, 1919), pp. 1-27, and H. DIELS, *Antike Technik* (Leipzig and Berlin, 1920), pp. 139 ff. For more recent literature cf. A. G. DEBUS, "The significance of the History of Early Chemistry", in *Cahiers d'Histoire mondiale*, IX (1965), p. 41 f. especially note 6.

most of the latter with the last two. According to what has been established before, the last two sections of the Nineveh fragment (7th century B. C.) and the Babylon fragment (12th century B. C.) correspond respectively to the first two topics of the papyri. The last topic (dyeing of wool with purple and purple substitutes) has no parallel in Mesopotamia[1].

With respect to the making of alloys in gold and silver colors, the recipes in the papyri speak of copper (also "white copper"), tin and several minerals which are difficult to identify. Several of the recipes speak quite explicitly about the economic purpose of these processes[2]. Such phrases occur as e. g. "(alloy) imitating silver of such a kind that it cannot be found out", "this will be... of the first quality which will deceive even the artisans", or "the metal will be equal to true... so much as to deceive even the artisans". Such phrases echo to a remarkable degree the two last lines of the "silver recipes" of the library of Assurbanipal : "This (kind of) silver cannot [be detected]"[3].

Equally important are the similarities encountered in comparing the techniques applied : oil is used in Egypt as well as in Mesopotamia as a reducing agent (beside respectively charcoal and flour), mineral salts serve as fluxes and solvents for impurities, and the methods of cleaning and polishing the alloys serve in both instances the purpose of producing a silvery appearance.

To illustrate the tenor and the content of the papyri, I quote here the first recipe of the Stockholm papyrus in the translation of E. R. Caley :

> Plunge Cyprian copper, which is well worked and shingled for use, into dyer's vinegar and alum and let soak for three days. Then for every mina of copper mix in 6 drachmas each of earth of Chios, salt of Cappadocia and lamellose alum, and cast. Cast skillfully, however, and it will prove to be regular silver. Place in it not more than 20 drachmas of good, unfalsified, proof silver, which the whole mixture retains and (this) will make it imperishable.

A second parallel can be established between the cuneiform and the Greek chemical texts in the techniques of dyeing pebbles to make them resemble gem stones,

1. Mesopotamia seems to have imported dyed wool from the West as we know from texts of the 14th and the 6th centuries B. C.

2. Let me also mention that the Stockholm papyrus stresses secrecy in one point (section 101) and for obvious economic reasons : "Keep this a secret because the purple has an extraordinary beautiful luster (translation of Caley)" at the beginning of a recipe dealing with the manufacture of an artificial purple dye. I would furthermore like to draw attention to the existence of doublettes of recipes in the papyri which parallels the doublette in section 2 and 3 of the Nineveh fragment (see above p. 39). The doublettes are introduced in the papyri by the word "another" (recipe).

3. The economic context within which alchemy as a "technique" of altering metals to one's advantage is located, cannot remain entirely outside consideration even in a philological investigation. The last centuries before the end of the first millennium B. C. saw an economic development of far reaching consequences. Coinage used in and around Greece already for several centuries swept through the neighboring regions from Egypt to Iran

and of producing such stones. More than 60 of the 115 recipes of the Stockholm papyrus are concerned with the dyeing of gems and about 70 deal with artificial gems. The small fragment found in Babylon (Text 1, see above p. 2) happens to contain what is left of two prescriptions of very similar nature, one to make a *pappardillu*-stone, and the other to produce a stone in the coloring of the *dušû*-stone.

The same methods seem to have applied in both groups of instructions ; alum and vinegar is used ; the stones are boiled in certain dyes ; the material of the artificial gems, i. e. crushed stones of characteristic colors, are held together by either honey or tragacanth ; and the covers are luted on the crucibles to close them airtight — "hermetically". Here are some recipes for the dyeing of stones taken from the Stockholm papyrus (in the translation of E. R. Caley), which illustrate the Greek methods :

Take and put so-called topaz stone in liquid alum and leave it there for 3 days. Then remove it from this and put it in a small copper vessel in which you have placed pure unadulterated verdigris along with sharp vinegar. Put the cover upon the vessel, close up the cover, and gently keep a fire under the vessel with olive wood for 6 hours, otherwise the longer you maintain the fire, the better and deeper will the stone be — only, as I say, with a gentle fire. Cool and lift the stone out. Its condition will show whether it has become emerald. That is to say, you will observe that a green film has formed over it. Let it become slowly cooled, however ; if not, it soon breaks. Put oil in a small box-tree vessel many days beforehand so that the oil is purified and the product from it can be taken off. Put in the stone and leave it under cover 7 days. On taking out you will have an emerald which resembles the natural ones.

or also :

Preparation of emeralds : Mix 1 part of roasted copper (and) 2 parts of verdigris with honey and place it upon the ashes. Let it cook and place the crystal in it.

and :

Put the stones in a dish, lay another dish on it as cover, lute the joint with clay, and let the stones be roasted for a time under supervision. Then remove the cover gradually and pour alum and vinegar upon the stones. Then afterward color the stones with the dye as you wish.

and beyond ; use began to be made of diverse metals such as gold, silver and copper, linked to each other in value relations that depended on systems of international commerce of increasing complexity. Shifts in value affected not only merchants and bankers but private persons of restricted means as well. This seems to have generated the desire to use, under certain conditions, "scientific" remedies to improve the metal of coins which may well have expressed itself through an intense concern with alchemy. It is probably therefore not an accident that it is the later of the two clay tablets here discussed that deals with the imitation of silver. After we hear from King Sennacherib (721-705 B. C.) that the Assyrians knew about copper coins (possibly under western, Lydian, influence), the cuneiform texts remain silent on this important topic. Our recipe from the library of Assurbanipal (668-627 B. C.) could therefore reflect a similar concern in coin metals. One should also mention in this context that the somewhat later economic documents from Southern Mesopotamia (Sippar, Babylon, Uruk, Ur, etc.) are very much aware of the quality of silver used as a means of payment and stress carefully the percentage of permissable admixtures.

On the other hand, we know from as early as the second half of the second millennium that gold and gold objects were adulterated (even when moved from palace to palace) and that tests were made to establish the true composition of gold received.

I have purposely refrained from discussing at any length the similarities and disparities in the technologies applied beyond pointing out a small number of duplications in purpose, ingredients and methods. What matters in this paper is the general analogy rather than specific parallels which are best considered coincidental.

One must realize that only a small fraction of the chemical literature of Mesopotamia (the glass texts excepted) has been preserved, and even if we are fortunate enough to have at our disposal two rather extensive papyri in Greek from the end of the third century A. D., we must keep in mind that much more is lost. Hence accidental similarities should not be stressed but rather the fact that the repertory of the chemical art, the concerns and methods of its craftsmen, have remained static across the gap in region and period which separates the clay tablets from the papyri. With the already pointed out exception of the dyeing of wool, the gamut of the chemist's craft was roughly the same in Babylonia before Nebuchadnezzar I, in the Assyrian empire before Assurbanipal, and in Ptolemaic Egypt. The papyri do therefore not present "Egyptian" chemistry — or even Hellenistic[1] — but the assembly of chemical traditions that were known and practiced from the Euphrates to the Nile since the 13th century B.C. if not earlier. As the glass technology and its history suggests, the direction of diffusion was basically westward and southward, although it is still difficult to detail this complex and slow process, or to discern earlier developments. The scribal tradition of Mesopotamia began to admit technical treatises into the traditional repertory of its tablet collection only in the last third of the second millennium B. C. Possible earlier attempts at chemistry have not come to light, and tablets of such content would be so rare as to be unlikely to be found. The extent of the chemist's skills before this date remains therefore hidden[2].

In conclusion I must justify the contention implied in my title : *Mesopotamia in the Early History of Alchemy.*

It is well known that the great transformation brought about by the influence of Greek philosophy on the basically practical chemistry of the ancient Near East took place in Egypt even before the date of the two Greek papyri which I have discussed. The fundamentally utilitarian intent of augmenting (the Greek texts speak of "doubling" and "tripling") metals, making alloys look like precious metals, and "manufacturing" expensive precious stones underwent a fateful change. In an entirely novel mood and on the wings of a new "theoretical" approach, new technical

1. Pliny the Elder (23-79 A. D.) already refers to the coloring of stones to increase their value (Book XXXVI 67).

2. The relationship between the ancient Near Eastern chemistry and that of India and China where alchemy evolved much later is not the concern of this study.

methods were devised in a quest for the "transmutation" of metals — of course, in the direction of economically preferred combinations of "atoms". Mystically oriented interpretations, magic and theurgic practices, and astrology combined with philosophy to accomplish the shift in outlook which separates the chemistry of the papyri from the alchemy of the Alexandrinian tradition. Under the same auspices took place the slow evolution of chemical knowledge and technology in the Islamic as well as in the Christian world during the subsequent millennium. Only under the pressure of a new and sustained interest in experiments could chemistry disengage itself from the luxuriant overgrowth of philosophical superstructures and mystical speculations, and embark on the search for an intellectually satisfying theoretical foundation.

The few fragments of clay tablets contribute to the history of chemistry — and that of science — the realization that the pre-alchemistic phase extended over as long a period as the alchemistic. The former appears now as rich in variety and as "international" as the latter, as well as scientific in character in the sense that experiments were made and results recorded and kept from the middle of the second millennium B. C. onward.